Ocean Color Level-2 Data Products

1.0 Introduction

This document describes the specifications of Ocean Color Level-2 archive products which are produced and distributed by the NASA Goddard Space Flight Center's Ocean Color Data Processing System (OCDPS). The products are implemented in the Hierarchical Data Format (HDF), and HDF terminology is used in this document.

These specifications are given in terms of the logical implementation of the products in HDF and are not a physical description of file contents. Therefore, HDF software must be used to create or read these products.

A Level-2 data product is generated from either a Level-1A (SeaWiFS or OCTS) or Level 1B (MODIS) product. The main data contents of the product are the geophysical values for each pixel, derived from the Level-1 radiance by applying the sensor calibration (for Level-1A), atmospheric corrections, and bio-optical algorithms. Each Level-2 product corresponds exactly in geographical coverage (scan-line and pixel extent) to that of its parent Level-1 product and is stored in one physical HDF file. Note that a number of fields were originally specified for the SeaWiFS data products and are not applicable to the other sensor products; these are indicated as SeaWIFS only.

2.0 Naming Convention

The form of a Level-2 file name is iyyyydddhhmmss.L2_ccc, where i is the instrument identifier (S for SeaWiFS, A for MODIS/Aqua, O for OCTS), yyyydddhhmmss are the GMT year, day of the year, hours, minutes, and seconds of the first scan line, and ccc is the coverage: GAC for Global Area Coverage (i.e., subsampled image data), LAC for Local Area Coverage (full-resoluton data), Hxxx for HRPT direct-broadcast (where xxx is a station identifier, e.g., HNSG for the NASA SeaWiFS station), or MLAC for merged LAC (multiple scenes from a single orbit merged into a single product). Examples of Level-2 file names are:

S1998001180514.L2_GAC	SeaWiFS GAC (4 km subsampled)
A2004032163500.L2_LAC	MODIS/Aqua LAC (1 km)
O1997001130032.L2_GAC	OCTS GAC (4 km subsampled)

3.0 Global Attributes

For global attributes that have constant values specific to this product type, the actual value is given.

3.1 Mission and Documentation

This section lists attributes which are common to all sensors, followed by sensor-specific attributes.

3.1.1 Common Attributes

Product Name (character): the name of the product file (without path).

Title (character): "SeaWiFS Level-2 Data", “MODISA Level-2 Data” or “OCTS Level-2 Data”..

Sensor Name (character): "SeaWiFS", “MODISA” or “OCTS”.

Replacement Flag (character): "ORIGINAL" if this is the first version of this product delivered to the DAAC; otherwise, it is set to the name of the product to be replaced (superseded) by the present product.

Software Name (character): "MSl12"; name of the software used to create this product.

Software Version (character): version of the software used to create this product.

Processing Time (character): local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Processing Control (character): path and name of the file containing the control parameters. This information is stored in the product as part of its processing history.

Input Parameters (character): all input and processing control parameters used by the calling program to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters. This information is stored in the product as part of its processing history.

Input Files (character): the names of the Level-1A or Level-1B file (without path; always listed first) from which the current product was created and of the ancillary (environmental) data files (without paths, each separated by one comma) used in the processing. This information is stored in the product as part of its processing history.

3.1.2 SeaWiFS-Specific Attributes

Data Center (character): "NASA/GSFC SeaWiFS Data Processing Center".

Station Name (character): "Wallops Flight Facility".

Station Latitude (4-byte real): 37.9272.

Station Longitude (4-byte real): -75.4753.

Mission (character): "SeaStar SeaWiFS".

Mission Characteristics (character): "Nominal orbit: inclination = 98.2 (Sun-synchronous); node = 12 noon local (descending); eccentricity = <0.002; altitude = 705 km; ground speed = 6.75 km/sec".

Sensor (character): "Sea-viewing Wide Field-of-view Sensor (SeaWiFS)".

Sensor Characteristics (character): "Number of bands = 8; number of active bands = 8; wavelengths per band (nm) = 412, 443, 490, 510, 555, 670, 765, 865; bits per pixel = 10; instantaneous field-of-view = 1.5835 mrad; pixels per scan = 1285; scan rate = 6/sec; sample rate = 7710/sec".

Data Type (character): "GAC".

3.2 Data Time

Start Time (character): start GMT of the first scan line of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

End Time (character): start GMT of the last scan line of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Scene Center Time (character): start GMT of the center scan line of the scene; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Node Crossing Time (character): GMT of descending node crossing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Start Year (2-byte integer): GMT year of first scan line of the scene.

Start Day (2-byte integer): GMT day-of-year of first scan line of the scene.

Start Millisec (4-byte integer): GMT milliseconds-of-day of start of the first scan line of the scene.

End Year (2-byte integer): GMT year of last scan line of the scene.

End Day (2-byte integer): GMT day-of-year of last scan line of the scene.

End Millisec (4-byte integer): GMT milliseconds-of-day of start of the last scan line of the scene.

Start Node (character): "Ascending" or "Descending"; describes node direction at the start of the scene.

End Node (character): "Ascending" or "Descending"; describes node direction at the end of the scene.

Orbit Number (4-byte integer): orbit number of the scene.

3.3 Data Structure

Pixels per Scan Line (4-byte integer): number of pixels in each scan line.

Number of Scan Lines (4-byte integer): number of scan lines in the scene.

Number of Bands (4-byte integer): 8; number of channels/wavelengths.

LAC Pixel Start Number (4-byte integer): the LAC pixel number corresponding to the first pixel in scan lines of this product (SeaWiFS only).

LAC Pixel Subsampling (4-byte integer): the subsampling rate for the pixels in this product relative to LAC scan lines (SeaWiFS only).

Scene Center Scan Line (4-byte integer): number of the center scan line (1-relative) of the scene, relative to first scan line.

Number of Scan Control Points (4-byte integer): number of rows in the **latitude** and **longitude** control point arrays.

Number of Pixel Control Points (4-byte integer): number of columns in the **latitude** and **longitude** control point arrays.

Mask Names (character): list of algorithm names (each separated by one comma, from the values of the attributes **f01_name** to **f24_name** of the **l2_flags** SDS in the Geophysical Data Vgroup) for the flag bits that were used as masks when generating this product.

Flag Percentages (4-byte real, array size 32): percentages of pixels in the scene for which a bit in **l2_flags** is set; each of the 32 values corresponds to one of the 32 bits (from lowest to highest) in **l2_flags**.

3.4 Scene Coordinates

Latitude Units (character): "degrees North"; units used for all latitude values in this product.

Longitude Units (character): "degrees East"; units used for all longitude values in this product.

Scene Center Latitude (4-byte real): latitude of the midpoint of the scene center scan line.

Scene Center Longitude (4-byte real): longitude of the midpoint of the scene center scan line.

Scene Center Solar Zenith (4-byte real): solar zenith angle of the midpoint of the scene center scan line.

Upper Left Latitude (4-byte real): latitude of the upper left scene corner.

Upper Left Longitude (4-byte real): longitude of the upper left scene corner.

Upper Right Latitude (4-byte real): latitude of the upper right scene corner.

Upper Right Longitude (4-byte real): longitude of the upper right scene corner.

Lower Left Latitude (4-byte real): latitude of the lower left scene corner.

Lower Left Longitude (4-byte real): longitude of the lower left scene corner.

Lower Right Latitude (4-byte real): latitude of the lower right scene corner.

Lower Right Longitude (4-byte real): longitude of the lower right scene corner.

Northernmost Latitude (4-byte real): northernmost latitude of all scan line end points.

Southernmost Latitude (4-byte real): southernmost latitude of all scan line end points.

Westernmost Longitude (4-byte real): westernmost longitude of all scan line end points.

Easternmost Longitude (4-byte real): easternmost longitude of all scan line end points.

Start Center Latitude (4-byte real): latitude of center pixel for first scan line.

Start Center Longitude (4-byte real): longitude of center pixel for first scan line.

End Center Latitude (4-byte real): latitude of center pixel for last scan line.

End Center Longitude (4-byte real): longitude of center pixel for last scan line.

Orbit Node Longitude (4-byte real): longitude of scene's orbit descending node (longitude at equatorial crossing of day-side node).

Earth-Sun Distance Correction (4-byte real): correction applied to radiance for irradiance changes caused by the annual Earth-Sun distance variation, computed as the square of the inverse of the distance in astronomical units.

4.0 Data Objects

Of the following data object groups, three (Scan-Line Attributes, Geophysical Data, and Navigation) contain data that are functions of scan lines. That is, each data object within these groups have data for each scan line and is therefore dimensioned by the value of the global attribute, **Number of Scan Lines**. Thus, to get all the data corresponding to a specific scan line, n, the n^{th} values of all data objects in these four groups would need to be read.

4.1 Scan-Line Attributes

The following data objects are SDSes belonging to the Vgroup "Scan-Line Attributes". Attributes of the SDSs are shown in **bold**.

year (4-byte integer, array size **Number of Scan Lines**): **long_name** = "Scan year"; **valid_range** = (1996, 2038); **units** = "years".

day (4-byte integer, array size **Number of Scan Lines**): **long_name** = "Scan day of year; **valid_range** = (1,366); **units** = "days".

msec (4-byte integer, array size **Number of Scan Lines**): **long_name** = "Scan-line time, milliseconds of day"; **valid_range** = (0,86399999), **units** = "milliseconds".

slat (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan start-pixel latitude"; **valid_range** = (-90.,90.); **units** = "degrees".

slon (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan start-pixel longitude"; **valid_range** = (-180.,180.); **units** = "degrees".

clat (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan center-pixel latitude"; **valid_range** = (-90.,90.); **units** = "degrees".

clon (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan center-pixel longitude"; **valid_range** = (-180.,180.); **units** = "degrees".

elat (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan end-pixel latitude"; **valid_range** = (-90.,90.); **units** = "degrees".

elon (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan end-pixel longitude"; **valid_range** = (-180.,180.); **units** = "degrees".

csol_z (4-byte real, array size **Number of Scan Lines**): **long_name** = "Scan center-pixel solar zenith angle"; **valid_range** = (0.,180.); **units** = "degrees".

4.2 Geophysical Data

The following data objects are SDSes belonging to the Vgroup "Geophysical Data". Attributes of the SDSs are shown in **bold**. Most parameters are stored as integers, which are scaled according to the attributes **slope** and i**ntercept** attached to each SDS. Parameters which are wavelength-specific (e.g., water-leaving radiance) have separate SDSs for each band used to derive the parameter; a list of wavelengths for each sensor is given in Table 2. This section lists those parameters which are stored in the standard archive products. A complete list of parameters that can be output by the software is given in the MSl12 User Guide.

nLw_WWW (2-byte integer, array size **Number of Scan Lines** x **Pixels per Scan Line**), where WWW is the band-center wavelength (see Table 2): **long_name** = "Normalized water-leaving radiance at WWW nm"; **units** = "mW cm^-2 um^-1 sr^-1"; **slope** and **intercept** are used to convert the integer values of into real-valued, geophysical units: **nLw_WWW*slope** + **intercept**; if not calculable, this field is set to zero.

chlor_a (4-byte real, array size **Number of Scan Lines** x **Pixels per Scan Line**): **long_name** = "Chlorophyll Concentration, OC4 Algorithm"; **slope** = 1.0; **intercept** = 0.0; **units** = "mg

m^-3"; **slope** and **intercept** are included mainly for historical reasons and consistency with other geophysical parameters ; if not calculable, this field is set to zero.

K_490 (2-byte integer, array size **Number of Scan Lines** x **Pixels per Scan Line**): **long_name** = "Diffuse attenuation coefficient at 490 nm"; **slope** = 0.0002; **intercept** = 0.0; **units** = "m^-1"; **slope** and **intercept** are used to convert the integer values of into real-valued, geophysical units: **K_490*****slope** + **intercept**; if not calculable, this field is set to zero.

eps_78 (byte, array size **Number of Scan Lines** x **Pixels per Scan Line**): **long_name** = "Epsilon of aerosol correction at 765 and 865 nm"; **slope** = 0.01; **intercept** = 0.0; **units** = "dimensionless"; **slope** and **intercept** are used to convert the byte values into real-valued, geophysical units: **eps_78*****slope** + **intercept**; if not calculable, this field is set to zero.

tau_WWW (2-byte integer, array size **Number of Scan Lines** x **Pixels per Scan Line**), where WWW is the band-center wavelength (see Table 2): **long_name** = "Aerosol optical thickness at WWW nm"; **slope** = 0.0001; **intercept** = 0.0; **units** = "dimensionless"; **slope** and **intercept** must be used to convert the integer values of into real-valued, geophysical units: **tau_WWW*****slope** + **intercept**; if not calculable, this field is set to zero.

angstrom_WWW (2-byte integer, array size **Number of Scan Lines** x **Pixels per Scan Line**), where WWW is the band-center wavelength (see Table 2): **long_name** = "Angstrom coefficient, WWW to 865 nm"; **slope** = 0.0002; **intercept** = 0.0; **units** = "dimensionless"; **slope** and **intercept** are used to convert the integer values of into real-valued, geophysical units: **angstrom_WWW*****slope** + **intercept**; if not calculable, this field is set to zero.

sst (byte, array size **Number of Scan Lines** x **Pixels per Scan Line**), MODIS only: **long_name** = "Sea Surface Temperature"; **slope** = 0.15; **intercept** = -3.0; **units** = "degrees-C"; **slope** and **intercept** are used to convert the byte values into real-valued, geophysical units: **sst*****slope** + **intercept**; if not calculable, this field is set to zero.

l2_flags (4-byte integer, array size **Number of Scan Lines** x **Pixels per Scan Line**): **long_name** = "Level-2 Processing Flags"; **units** = "dimensionless"; 32 bits in two bytes used as indicators of certain conditions (see Table 3). The following attributes provide the names of the algorithms (also listed in Table 3) used in determining the setting of the corresponding bits in **l2_flags** (the least significant bit being the first bit): **f01_name** = "ATMFAIL"; **f02_name** = "LAND"; **f03_name** = "BADANC"; **f04_name** = "HIGLINT"; **f05_name** = "HILT"; **f06_name** = "HISATZEN"; **f07_name** = "COASTZ"; **f08_name** = "NEGLW"; **f09_name** = "STRAYLIGHT"; **f10_name** = "CLDICE"; **f11_name** = "COCCOLITH"; **f12_name** = "TURBIDW"; **f13_name** = "HISOLZEN"; **f14_name** = "HITAU"; **f15_name** = "LOWLW"; **f16_name** = "CHLFAIL"; **f17_name** = "NAVWARN"; **f18_name** = "ABSAER"; **f19_name** = "TRICHO"; **f20_name** = "MAXAERITER"; **f21_name** = "MODGLINT"; **f22_name** = "CHLWARN"; **f23_name** = "ATMWARN"; **f24_name** = "DARKPIXEL"; **f25_name** = "SEAICE"; **f26_name** = "NAVFAIL"; **f27_name** = "FILTER"; **f28_name** = "SSTWARN"; **f29_name** = "SSTFAIL"; **f30_name** and **f31_name** = "SPARE"; **f32_name** = OCEAN". The algorithms associated with these

names, and the use of the corresponding bits as masks or as flags, are described in volumes of the SeaWiFS TM Series.

Table 1. Summary of Level-2 geophysical parameters.

Parameter	**Storage (bytes)**	**Approximate Range**	**Units**
nLw_WWW	2	0 - 32	mw cm^{-2} um^{-1} sr^{-1}
chlor_a	4	0 - 100	mg m^{-3}
K_490	2	0 - 6.4	m^{-1}
tau_WWW	2	0 - 3.2	none
angstrom_WWW	2	-6.4 - 6.4	none
eps_78	1	0 - 2.5	none
sst	1	-3 - 35	degrees C

Table 2. Band-center wavelengths by sensor (nm). These are used in the geophysical parameter names that are based on wavelength.

SeaWiFS	MODIS	OCTS
412 (1)	412 (1)	412 (1)
443 (1)	443 (1)	443 (1)
490 (1)	488 (1)	490 (1)
510 (1),(2)	531 (1),(2)	520 (1),(2)
555 (1)	551 (1)	565 (1)
670 (1)	667 (1)	670 (1)
765	748	765
865 (3)	869 (3)	865 (3)

(1) Used for **nLw_WWW**
(2) Used for **angstrom_WWW**
(3) Used for **tau_WWW**

Table 3. Conditions indicated for the pixel associated with the setting of individual bits in l**2_flags**. These correspond to the algorithm names given by the attributes of **l2_flags**.

Bit Set = 1	**Condition Indicated**	**Algorithm Name**
1	atmospheric correction failure from invalid inputs	ATMFAIL
2	land	LAND
3	missing ancillary data	BADANC
4	severe Sun glint	HIGLINT
5	total radiance above knee in any band	HILT
6	satellite zenith angle above limit	HISATZEN
7	shallow water	COASTZ
8	negative water-leaving radiance in any band	NEGLW
9	stray light contamination	STRAYLIGHT
10	clouds and/or ice	CLDICE
11	coccolithophore	COCCOLITH
12	turbid, case-2 water	TURBIDW
13	solar zenith angle above limit	HISOLZEN
14	high aerosol concentration	HITAU
15	low water-leaving radiance at 555 nm	LOWLW
16	chlorophyll not calculable	CHLFAIL
17	questionable navigation (e.g, tilt change)	NAVWARN
18	absorbing aerosol index above threshold	ABSAER
19	trichodesmium	TRICHO
20	maximum iterations of NIR algorithm	MAXAERITER
21	moderate Sun glint	MODGLINT
22	chlorophyll out of range	CHLWARN
23	epsilon out of range	ATMWARN
24	dark pixel (Lt - Lt < 0) for any band	DARKPIXEL
25	sea ice in pixel (based on climatology)	SEAICE
26	navigation failure condition indicated in nav flags	NAVFAIL
27	insufficient valid neighboring pixels for epsilon filtering	FILTER
28	sea surface temperature warning flag (MODIS only)	SSTWARN
29	sea surface temperature falure flag (MODIS only)	SSTFAIL
30 - 31	spare flags	SPARE
32	clear ocean data (no clouds, land or ice)	OCEAN

4.3 Navigation Control Points and Tilt

The following data objects are SDSes belonging to the Vgroup "Navigation". Attributes of the SDSs are shown in **bold**. The control point arrays **latitude** and **longitude** are used for Level-3 processing and display. The most accurate geolocation will be obtained for SeaWiFS using the navigation block fields with the SeaWiFS Project software (see 4.4.4, below), and for MODIS using the Geolocation product.

cntl_pt_cols (4-byte integer, array size **Number of Pixel Control Points**): **long_name** = "Pixel control points"; **units** = "none"; array of pixel indices corresponding to **latitude** and **longitude** SDSs.

cntl_pt_rows (4-byte integer, array size **Number of Scan Control Points**): **long_name** = "Scan control points"; **units** = "none"; array of scan line indices corresponding to **latitude** and **longitude** SDSs.

longitude (4-byte real, array size **Number of Scan Control Points** x **Number of Pixel Control Points**): **long_name** = "Longitudes at control points";**units** = "degrees"; **valid_range** = "-180., 180."; **units** = "degrees"; longitudes of pixels indicated by **cntl_pt_cols** and **cntl_pt_rows**.

latitude (4-byte real, array size **Number of Scan Control Points** x **Number of Pixel Control Points**): **long_name** = "Latitudes at control points";**units** = "degrees"; **valid_range** = "-90., 90."; **units** = "degrees"; latitudes of pixels indicated by **cntl_pt_cols** and **cntl_pt_rows**.

tilt (4-byte real, array size **Number of Scan Lines**): **long_name** = "Tilt angle for scan line"; **valid_range** = (-20.1,20.1); **units** = "degrees"; positive values indicate aft tilts and negative values indicate forward tilts.

4.4 SeaWiFS Navigation Block (SeaWiFS only)

The following data objects are additional SDSes belonging to the Vgroup "Navigation" in SeaWiFS data products. Attributes of the SDSs are shown in **bold**. See the *SeaWiFS Postlaunch Technical Report Series*, volume 16 for a description of methods used for the operational navigation of SeaWiFS data.

orb_vec (4-byte real, array size **Number of Scan Lines** x 3): **long_name** = "Orbit position vector at scan line time"; orbit position vector interpolated to the time of the scan line; **valid_range** = (-7200.,7200.); **units** = "kilometers"; used to determine spacecraft position for geolocation.

sun_ref (4-byte real, array size **Number of Scan Lines** x 3): **long_name** = "Reference Sun vector in ECEF frame"; unit Sun vector in the Earth-cetered, Earth-fixed (ECEF) frame; **valid_range** = (-1.,1.); used for computing solar zenith and azimuth angles.

att_ang (4-byte real, array size **Number of Scan Lines** x 3): **long_name** = "Computed yaw, roll, pitch"; **valid_range** = (-180.,180.); relates spacecraft position to orbit reference frame.

sen_mat (4-byte real, array size **Number of Scan Lines** x 3 x 3): **long_name** = "ECEF-to-sensor-frame matrix"; **valid_range** = (-1.,1.); relates sensor scan plane to Earth-fixed reference frame (3x3 matrix, in column-major order).

scan_ell (4-byte real, array size **Number of Scan Lines** x 6): **long_name** = "Scan-track ellipse coefficients"; defines scan-track geometry in sensor frame.

nflag (4-byte integer, array size **Number of Scan Lines** x 8): **long_name** = "Navigation flags"; in the 8-integer array, the integers represent, respectively: navigation failure flag; orbit flag; Sun sensor flag; Earth sensor flag; spacecraft attitude uncertainty flag; time code flag; tilt data flag; and navigation warning flag. All flags may have the value 0 for valid or 1 for invalid. The tilt data flag only may also have the value of 2 to indicate a changing tilt. Note that the failure flag is only to 1 if the orbit flag, time code flag or tilt data flag are set to 1.

4.5 Sensor Tilt (SeaWiFS only)

The following data objects are SDSes belonging to the Vgroup "Sensor Tilt" in the SeaWiFS data products. Attributes of the SDSs are shown in **bold**.

ntilts (4-byte integer): **long_name** = "Number of scene tilt states".

tilt_flags (2-byte integer, array size 20): **long_name** = "Tilt indicators"; **valid_range** = (-1,3); tilt flags corresponding to each tilt state in the scene; possible values are 0 for nadir tilt, 1 for forward tilt, 2 for aft tilt, and 3 to indicate a changing tilt angle; -1 indicates an unknown state; contains **ntilts** valid values.

tilt_ranges (2-byte integer, array size 20 x 2): **long_name** = "Scan-line number ranges of scene tilt states"; first and last scan line numbers (1-relative) corresponding to each tilt state in the scene; contains **ntilts** valid values.

4.6 Sensor Band Parameters

The following data objects are SDSes belonging to the Vgroup "Sensor Band Parameters". Attributes of the SDSs are shown in **bold**. These parameters are used in the Level 2 processing.

wavelength (4-byte integer, array size **Number of Bands**); **long_name** = "Wavelengths"; **units** = "nm"; band center wavelength for each SeaWiFS band.

vcal_gain (4-byte real, array size **Number of Bands**); **long_name** = "Vicarious Calibration Gain"; **units** = "dimensionless"; vicarious calibration gain for each SeaWiFS band.

vcal_offset (4-byte real, array size **Number of Bands**); **long_name** = "Vicarious Calibration Offset"; **units** = "mW cm^-2 um^-1 sr^-1"; vicarious calibration offset for each SeaWiFS band.

F0 (4-byte real, array size **Number of Bands**); **long_name** = "Mean Solar Flux"; **units** = "mW cm^-2 um^-1 sr^-1"; mean solar flux for each SeaWiFS band.

k_oz (4-byte real, array size **Number of Bands**); **long_name** = "Ozone Absorption Coefficient"; **units** = "cm^-1"; ozone absorption coefficient for each SeaWiFS band.

Tau_r (4-byte real, array size **Number of Bands**); **long_name** = "Rayleigh Optical Thickness"; **units** = "dimensionless"; Rayleigh optical thickness for each SeaWiFS band.

4.7 Calibration (SeaWiFS only)

The following data objects are SDSes belonging to the Vgroup "Calibration" in the SeaWiFS data products. Attributes of the SDSs are shown in **bold**. See the *SeaWiFS Postlaunch Technical Report Series*, volumes 9 and 22 for a description of the operational algorithms used for applying the sensor calibration to SeaWiFS Level-1A data. Calibration values are those obtained from the calibration table for the first scan line of this Level-1A product.

entry_year (2-byte integer): **long_name** = "Calibration entry year"; the year (4 digits) that the entry used for this Vgroup's data was made in the sensor calibration table.

entry_day (2-byte integer): **long_name** = "Calibration entry day-of-year"; the day-of-year that the entry used for this Vgroup's data was made in the sensor calibration table.

ref_year (2-byte integer): **long_name** = "Calibration reference year"; 1997; the year of the calibration reference time (time of transfer of the SeaWiFS calibration to orbit).

ref_day (2-byte integer): **long_name** = "Calibration reference day-of-year"; 64; the day of year of the calibration reference time (time of transfer of the SeaWiFS calibration to orbit).

ref_minute (2-byte integer): **long_name** = "Calibration reference minute-of-day"; 720; the minute of day of the calibration reference time (time of transfer of the SeaWiFS calibration to orbit).

ms1_const (8-byte real, array size 8): **long_name** = "Mirror-side1 constant correction factors"; mirror side-1 constant correction factors for calibration of the eight bands (dimension is bands).

ms2_const (8-byte real, array size 8): **long_name** = "Mirror-side2 constant correction factors"; mirror side-2 constant correction factors for calibration of the eight bands (dimension is bands).

ms1_linear (8-byte real, array size 8): **long_name** = "Mirror-side1 linear correction factors"; mirror side-1 linear correction factors for calibration of the eight bands (dimension is bands).

ms2_linear (8-byte real, array size 8): **long_name** = "Mirror-side2 linear correction factors"; mirror side-2 linear correction factors for calibration of the eight bands (dimension is bands).

t_const (8-byte real, array size 8): **long_name** = "Time-dependent correction constant terms"; time-dependent correction constant terms for all bands.

t_linear (8-byte real, array size 8): **long_name** = "Time-dependent correction linear coefficients"; time-dependent correction exponential decay multiplier for all bands.

t_exponential (8-byte real, array size 8): **long_name** = "Time-dependent correction exponential coefficients"; time-dependent correction exponential decay time constant for all bands.

cal_offs (8-byte real, array size 8): **long_name** = "Calibration system offsets"; calibration system offsets for all bands.

counts (4-byte real, array size 8 x 4 x 5): **long_name** = "Digital counts of calibration knees"; **valid_range** = (0,1023); digital counts (zero-offsets corrected) corresponding to each calibration knee for all gains and bands (dimensions are bands x gains x knees).

rads (4-byte real, array size 8 x 4 x 5): **long_name** = "Radiances of calibration knees"; radiances corresponding to each calibration knee for all gains and bands (dimensions are bands x gains x knees).